

# **What Have We Learned in Seven Conferences on Unburned Carbon on Utility Fly Ash**

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## **A Review of Past Conferences**

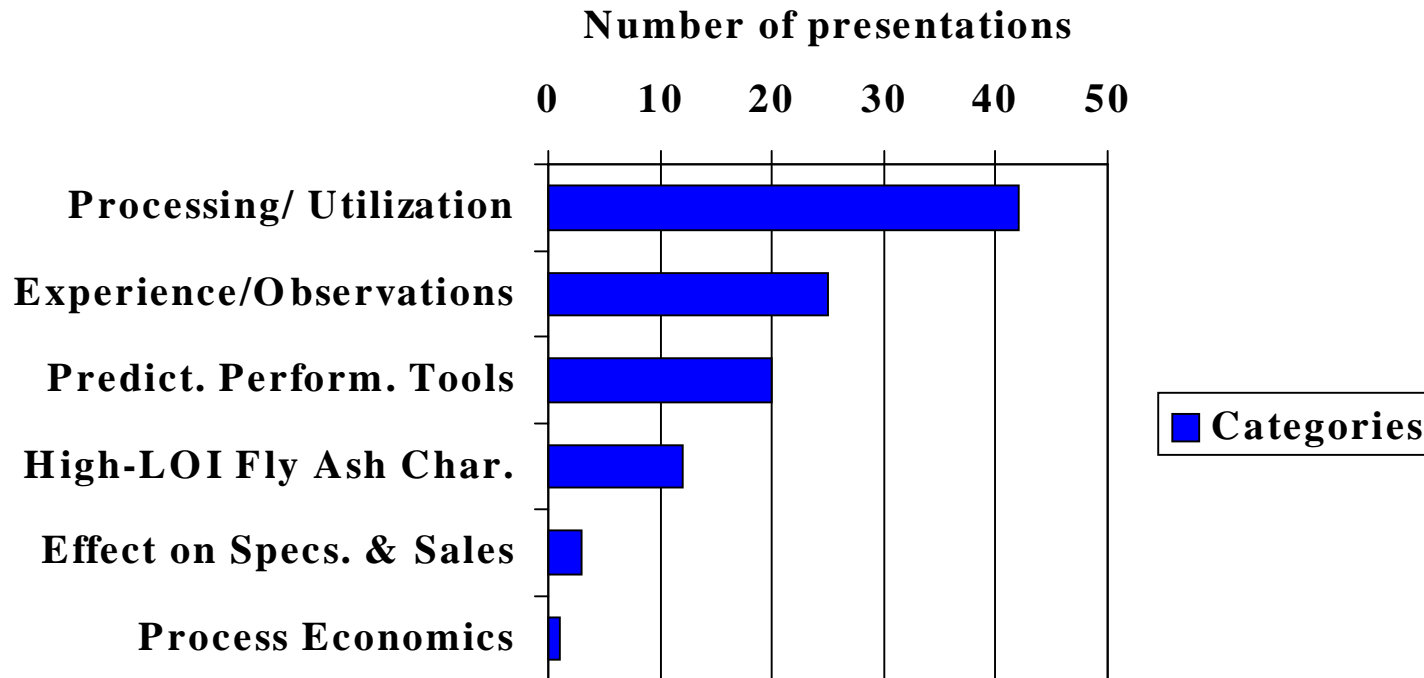
**Thomas C. Ruppel  
Parsons Corporation**

**2002 Conference on  
Unburned Carbon on Utility Fly Ash**

**May 14, 2002**

# Categories from Technical Presentations

## Frequency of Topical Presentations



# **What Have We Learned?**

- ★ Control Measures for UBC**
- ★ Instrumentation to Measure Unburned**
- ★ Beneficiation of High-LOI Fly Ash**
- ★ New Uses for High-LOI Fly Ash**
- ★ Characterization of High-LOI Fly Ash**

## **Control Measures for UBC Presented at the Conferences**

- ★ Balancing coal distribution among**
- ★ Combustion optimization software**
- ★ Improving the three T's (time,**
- ★ Increasing the fineness (decreasing**

# **Control Measures for UBC Presented at the Conferences**

## **Continued**

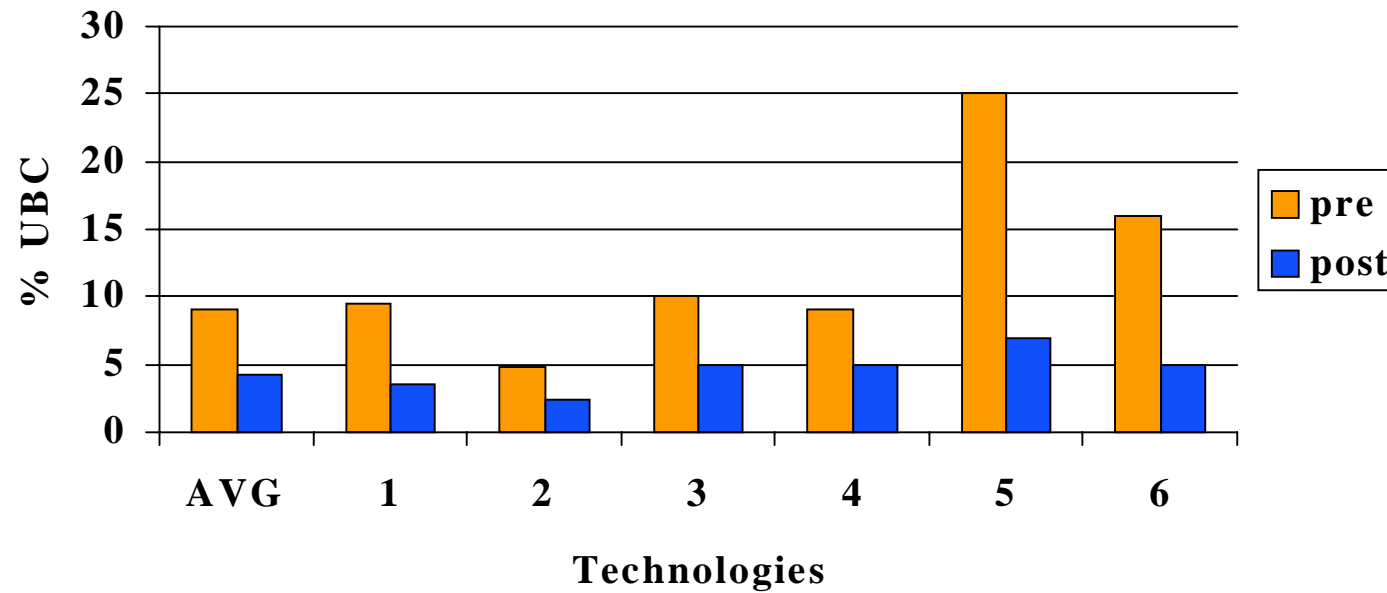
- ★ Increasing the thickness of the furnace slag layer**
- ★ Low-NOx-burners**
- ★ Natural gas cofiring**
- ★ Overfire air**
- ★ Slagging combustors**

# **Control Measures for UBC Presented at the Conferences continued**

- \* Optimizing Engineering Parameters:**
  - a. ash loading**
  - b. boiler unit load**
  - c. excess air**
  - d. firing system design**
  - e. furnace internal fuel-air swirl**
  - f. heating value of coal**
  - g. moisture**
  - h. mill bias, maintenance, tilt angle,  
and air flow**
  - i. residence time**

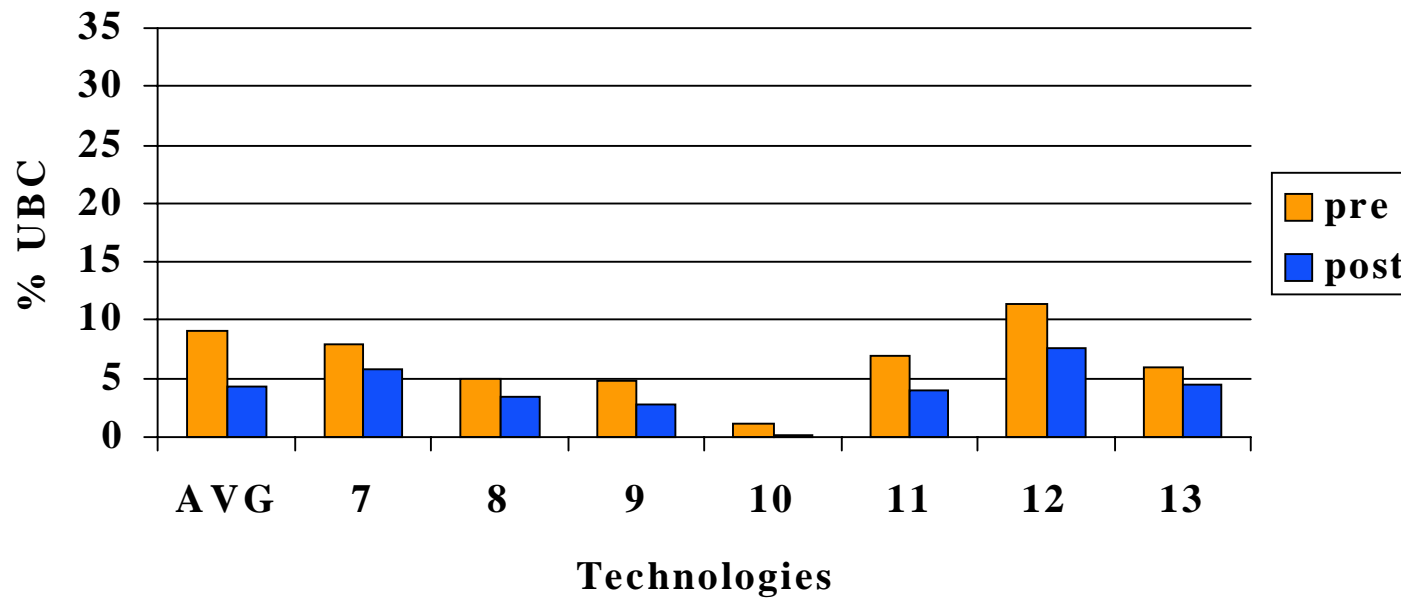
# % UBC

## UBC levels pre- & post- combustion modifications



## % UBC (cont'd)

**UBC levels  
pre- & post- combustion modifications**



# **Instrumentation to Measure Unburned Carbon on Fly Ash On-Line – In-Situ**

- ★ Dielectric strength of particle** (Sekam, Clyde)
- ★ Infrared absorption by particles**
- ★ Microwave absorption by particles**
- ★ Optical sensors** (MK Eng., MA)
- ★ Spectrophotometer** (Concarb 2000, PA)

# **Instrumentation to Measure Unburned Carbon on Fly Ash On-Line – Extractive**

- ★ **Infrared reflectance by particles**

(RCA, M&W Asketeknik, Denmark)

- ★ **Microwave absorption by particles**

(CAMRAC, PA)

# **Instrumentation to Measure Unburned Carbon on Fly Ash Off-Line**

**Based on:**

- ★ Color of fly ash** (Shamrock Env., FL )
- ★ Gravimetric** (HOT FOIL LOI, FERC, CA)
- ★ Subsonic signal from a carbon-in-ash  
sample irradiated with visible light**

(IA State Univ.)

## **Beneficiation of High-LOI Fly Ash**

- ★ Acoustically agitated bubbling fluidized bed** (Lehigh Univ., PA)
- ★ Electrostatic separation** (STI, MA)
- ★ Froth flotation** (MTU)

# **Beneficiation of High-LOI Fly Ash Continued**

## **★ Pneumatic transport separator**

**(Tribo Flow Sepns. & UKY)**

## **★ Triboelectric (triboelectrostatic)**

**(9 presentations)**

## **★ Vibrating electrostatic separator**

**(Minerals & Coal Tech., VA, Korean coals)**

# **High-LOI Fly Ash**

## **Carbon Reduction by Burn-Off**

- ★ **Carbon burnout via a close-coupled burn-out reactor** (Prog. Matls., FL and SC Elec. & Gas)
- ★ **Microwave heating to decarbonize low-LOI fly ash** (Microwave Tech. Corp., Canada)
- ★ **Recycling beneficiated high-LOI fly ash back into furnace** (New England Power, STI process, then recycle C-rich stream)

## **New Uses for High-LOI Fly Ash**

- ★ Activated carbon source** (Penn State Univ.)
- ★ Autoclaved aerated concrete (as a sawable nonrotting wood replacement)**
- ★ Cement kiln fuel** (Morrison Technology, ME)

# **New Uses for High-LOI Fly Ash Continued**

- ★ Concrete manufacture** (9 presentations)  
**Construction materials (e.g., concrete blocks, ash bricks, panels)** (Univ. of Denver)
- ★ Flowable fill (low load strength backfill)** (Hands On Tech!, MA)

# **New Uses for High-LOI Fly Ash Continued**

**★ Industrial binder for metal casting and  
(MTU)**

**★ Improved structural fill (subgrade/**

**Robert Kimball Assoc., PA)**

**★ Phosphoric acid-based cements and**

**(Answer Tech., IL)**

## **New Uses for High-LOI Fly Ash Continued**

- ★ Reinjection of fly ash into power plant slip-stream (mercury removal)**

(ADA Tech., CO)

- ★ Siliceous material source for vitrification to glass and ceramics**

(Vortec Corp., PA)

- ★ Soil amendments ("crops grow well"), food crops contain low levels of ash metals (SCS, AL)**

# What Have We Learned?

## ★ Characteristics of UBC:

Initial BET surface area:

activated to ca.

## **What Have We Learned? Continued**

### **★ Characteristics of UBC, continued:**

**d) Porosity: 20-500 Å (mesopore range)**

**e) Bulk densities: 1.5 to 1.95 g/cc**

**f) Appears to have the structure of highly  
disordered graphite**

## **What Have We Learned? Continued**

- \* Process improvements undertaken to reduce NOx emissions and improve boiler operation can reduce UBC levels by approximately half.**

# **What Have We Learned?**

## **Continued**

- ★ Based on a number of conference presentations, we now have information on about a dozen techniques for each of the following:**
  - a) Measuring UBC on fly ash**
  - b) Separating (beneficiating) UBC from fly ash**
  - c) New uses for high-LOI fly ash.**

## **What Have We Learned? Continued**

- \* Conference confirmed that control of UBC on flyash by combustion modification must be replaced by or coupled with SCR and/or SNCR to meet NOx emission requirements**

# **What Hasn't the Conference Heard Yet?**

## **Effects on Unburned Carbon**

- ★ Burners out of service**
- ★ Combination of combustion/post-combustion technologies**
- ★ Flue gas recirculation**
- ★ Reduced air preheat**
- ★ Steam or water injection**
- ★ Ultra-low excess air**
- ★ Clear Skies Initiative**

## **Unburned Carbon Conference Team Members**

- ★ Tom Sarkus, NETL, Conference Chair**
- ★ Leo Makovsky, NETL, Team Leader**
- ★ Karen Lockhart, Science Applications  
International Corporation (SAIC),  
Certified Conference Planner**
- ★ Al Mann – Parsons Corporation**
- ★ Tom Ruppel – Parsons Corporation**